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Detrended-Fluctuation Analysis of Nematode Movement in Heterogeneous Environment

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Abstract: We consider multifractal analysis in time scale to analyse the effect of structural heterogeneity on the movement of the slug-parasitic nematode, Phasmarhabditis hermaphrodita. The study involves image recording and analysis of nematode movement on a homogeneous layer of technical agar compared to movement of nematodes in a structurally heterogeneous environment that was created by adding sand particles to the plates of agar. The temporal scaling properties of the recorded trails were studied using a detrended fluctuation based method to capture the complex dynamic of movement data by comparing the multiscaling characteristics of nematode step lengths as affected by the different environments.
A systematic analysis of the exponent of the structure function and the generalized Hurst exponent revealed that, while in homogeneous environment the movement was characterized by a long-range correlation with a Hurst exponent H(q) close to 1, varying little with respect to the order q of the fluctuation function, the impact of sand particle was to reduce the degree of persistence in the movement, the step lenghts being characterized by a smaller Hurst exponent, yet more variable. The results suggest that the presence of structural heterogeneity introduces a new bias into the movement, which plays an important role in complex environments where the nematode movement may be obstructed by soil particles.

References

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